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EDUCATION: Ph.D. Geophysics, 1987, State University of New York, Binghamton  
M.A. Geophysics, 1973 University of California, Berkeley  
B.A. Physics, 1971 University of California, Berkeley

PROFESSIONAL HISTORY:

9/2007 to present: Lawrence Berkeley National Laboratory, Earth Sciences Department: Application of seismology to characterize geothermal reservoirs. Research on synthesizing ground motion for earthquake hazard analysis.

4/91 to 2007: Lawrence Livermore National Laboratory, Earth and Atmospheric Department: Research on developing tomographic approaches to investigate geothermal reservoirs. Research on predicting earthquake ground motion for design of structures and site response analysis for engineering applications; research on source characteristics of small and large earthquakes and inversion for velocity and attenuation structure for geothermal exploration. PI for several projects.

1989 to 1991: Bechtel Corporation, Earth Sciences Department, San Francisco: Earthquake hazard analysis for engineering design; specializing in ground motions for building designs.

1986 to 1989: Lawrence Livermore National Laboratory, Earth Sciences Department: Post-doctoral appointment. Research on earthquake locations with sparse data. Research on source characteristics of small earthquakes. Analysis of small earthquakes in geothermal environments.

1982 to 1986: State University of New York: Thesis research under Dr. Francis Wu. Thesis: Modeling Strong Earthquake Ground Motion with Empirical Green's Functions.

1974 to 1982: Woodward-Clyde Consultants, San Francisco: Project leader in strong ground motion, plate tectonic, and seismicity studies for earthquake hazard analysis for nuclear reactors, hydroelectric dams, and urban structures; specializing in field studies to incorporate seismology with geologic studies. Microearthquake analysis studies in Ecuador, Colombia, Peru, and El Salvador.

PROFESSIONAL ASSOCIATIONS:

Associate Editor, Seismology: Bollettino Di Geofisica Teorica ed Applicata, Italy

Reviewer: Yucca Mt. Ground Motion, Bechtel/SAIC, 2002, 2006.

Co-director, Hazards Mitigation Center, LLNL, 2003-2007.

Board of Directors: Acceleron Technologies 1996 – 2007.

COMPUTER PROGRAMS:

Hutchings, Lawrence et al. (2007) Software for Physically Based Seismic Hazard Analysis: EMPSYN, HAZARD, NetMoment, HazStats, COMPARE. Programs are available by download:

<http://www.gyte.edu.tr/earthquake/>.

SimulQ, inversion for Q structure: Zucca and Hutchings (1994); Regloc, multi-phase regional earthquake locations: Hutchings (1994).

PATENTS:

System and Method for Measuring Movement of Objects; #5724265, 1996, USA.

Continuation; System and Method for Measuring Movement of Objects; #5899963, 1997, USA.

Continuation; System and Method for Measuring Movement of Objects; #603452, 1998, USA.

System and Method for Determining Absolute Rotations in Three-dimensions; #6122960, 1999, USA.  
System and Method of Determining the Location of Mobil Personnel (w/ultrasound); #09790071.6, 2009.  
MOVIE: Rapid and Cheap Reservoir Modeling with Micro-earthquakes  
[//earthquake.usgs.gov/regional/nca/seminars/2012-11-07/](http://earthquake.usgs.gov/regional/nca/seminars/2012-11-07/)

#### PUBLICATIONS:

- Guilham, Aurelei, Lawrence Hutchings, Doug Dreger and Lane Johnson (2013) Moment Tensor Inversions of Small Earthquakes in the Geysers Geothermal Fields, California. Submitted *Journal Geophy Res.*
- Papoulia, J., Y. M. Fahjan, L. Hutchings, and Tatyana Novikova (2012) Physically Based Prediction of Broadband Strong Ground-Motion Hazards in the Saronikos Gulf, Greece, from a Potential M=6.5 Earthquake. In review, *Journal of Geophysics*.
- Hutchings, L. and Gisela Viegas (2012) Application of Empirical Green's Functions in Earthquake Source, Wave Propagation and Strong Ground Motion Studies". Earthquake Research and Analysis, New Frontiers in Seismology, chapter 3, pp. 87 – 140. Edited by Sebastiano D'Amico, InTech Publishing, on-line link: <http://www.intechopen.com/articles/show/title/application-of-empirical-green-s-functions-in-earthquake-source-wave-propagation-and-strong-ground-motion>.
- Godoladze, Tea, Lawrence Hutchings, and Z. Javakhishvili (2012) Seismo-tectoncs and Earthquake Hazards of the Tbilisi Area, Republic of Georgia. In review, *Bollettino Di Geofisica Teorica*
- Bonner, Brian and Lawrence Hutchings (2011) Rock Physics Interpretations for Reservoir Properties from Micro-earthquake Recordings. submitted *GEOPHYSICS*, GEO-2011-0031.
- Hutchings, Lawrence, Steve Jarpe, Katie Boyle, Gisela Viegas, and Ernest Majer (2011) Inexpensive, Automated Micro-Earthquake Data Collection and Processing System for Rapid, High-Resolution Reservoir Analysis. *Geothermal Res. Council, Transactions*, 2011 Annual Meeting, San Diego, CA
- Viegas, G. and L. J. Hutchings (2011). Characterization of induced seismicity near an injection well at the Northwest Geysers geothermal field, California, *Geothermal Resources Council Transactions*, 35.
- Viegas, G. and L. J. Hutchings (2010). Source Characteristics of Micro-earthquakes at the Northwest Geysers Geothermal Field, California, *Geothermal Resources Council Transactions*, 34, 1265-1272.
- Hutchings, Lawrence, Katie Boyle, and Steve Jarpe (2010) Toward High Resolution Tomography and Rock Physics Interpretation for Reservoir Properties. *Geothermal Res. Council, Transactions*, 17, 2010 Annual Meeting, Sacramento, CA
- Hutchings, L., K. Boyle, and S. Jarpe (2010). Near-real Time Interpretation of Microearthquake Data for Reservoir Modeling. *Geothermal Res. Council, Transactions*, 17, 2010 Annual Meeting, Sacramento, CA.
- Scognamiglio, Laura and Lawrence Hutchings (2009) A test of a physically-based strong ground motion prediction methodology with the 27 September 1997, Mw = 6.0 Colfiorito (Umbria-Marcha sequence), Italy earthquake. *Tectonophysics* 476, 145-158.
- Gok, Rengin, Lawrence Hutchings, Kevin Mayeda, and Dogan Kalafat (2009) Source parameters for 1999 North Anatolian fault zone aftershocks. *Pure and Applied Geophysics* 166, 547-566.
- Boyle, K. and Hutchings, L.J. (2009). Automated Processing and High Resolution Event Location at the Salton Sea Geothermal Reservoir. *Res. Council, Transactions*, 16, 2009 Annual Meeting, Reno, NV.
- Boyle, Katie, Lawrence Hutchings, Brian Bonner, Bill Foxall, and Paul Kasameyer (2007) Double Difference Earthquake Locations and Tomography at the Salton Sea Geothermal Reservoir. *Geothermal Res. Council, Transactions*, 14, 2007 Annual Meeting, Reno, NV.
- McCallen, D.B, A. Astaneh-Asl, S.C. Larsen and L. J. Hutchings (2009) The Response of Long-Span Bridges to Low Frequency, Near-Fault Earthquake Ground Motions. *TCLEE 2009: Lifeline Earthquake Engineering in a Multihazard Environment* ©2009 ASCE 165.
- Boyle, Katie, Lawrence Hutchings, Brian Bonner, Bill Foxall, and Paul Kasameyer (2007) Double Difference Earthquake Locations and Tomography at the Salton Sea Geothermal Reservoir. *Geothermal Res. Council, Transactions*, 14, 2http://earthquake.usgs.gov/regional/nca/seminars/2012-

- 11-07/007 Annual Meeting, Reno, NV.
- Hutchings, Lawrence, Eleni Ioannidou, Ioannis Kalogeras, Nicholas Voulgaris, Jean Savy, William Foxall, Laura Scognamiglio, and George Stavrakakis (2007) A physically based strong ground-motion prediction methodology; Application to PSHA and the 1999 M=6.0 Athens Earthquake. *Geophys. J. Int.* 168, 569-680.
- Bonner, Brian, Lawrence Hutchings, and Paul Kasameyer (2006) A Strategy for Interpretation of Microearthquake Tomography Results in the Salton Sea Geothermal Field Based upon Rock Physics Interpretation of State 2-14 Borehole Logs. *Geothermal Res. Council, Transactions*, 14, 2006 Annual Meeting, Reno, NV. LLNL, UCRL-PROC-222141.
- McCallen, D., A. Astaneh-Asl, S. Larsen, and L. Hutchings (2006) Dynamic Response of The Suspension Spans of the San Francisco-Oakland Bay Bridge. LLNL, UCRL-CONF-216798. Proceedings of eighth U.S. National Conference on Earthquake Engineering. April 18-22, 2006, San Francisco, pp. 10. proceedings EERI conference April, 2006.
- Kasameyer, Paul W., Lawrence Hutchings, Michael F. Ellis (2005) MEMS-based INS Tracking of Personnel in a GPS-denied Environment. ION GNSS 18th International Technical Meeting of the Satellite Division.
- Gok, Rengin and Lawrence Hutchings (2004) Broadband Green's Functions for the 1999 Marmara Earthquake Region Based on Local Earthquake Recordings. American Geophysical Union, Spring Meeting 2004, abstract.
- Mayer, Alan, Hutchings, Lawrence J. and Paul W. Kasameyer (2002) Tomographic imaging of the geologic structure in the Salton Sea Geothermal Field. *The Journal of the Acoustical Society of America*, vol. 112, no. 5, p. 2380-2389.
- Ioannidou, Eleni, Ioannis Kalogeras, Nicholas Voulgaris, Lawrence Hutchings, and George Stavrakakis (2001) Analysis of Site Response in the Athens Area from the 7 September 1999, Mw=5.9 Athens Earthquake and Aftershock Recordings, and Intensity. Special Issue on Site Response, *Bollettino di Geofisica teorica ed applicata*, V 42, 183-208. Trieste, Italy.
- Baise, Laurie, Lawrence Hutchings, and Steven Glaser (2001) Analysis of Site Response at Yerba Buena Island, San Francisco Bay, California from Weak Motion Recordings. Special Issue on Site Response, *Bollettino di Geofisica teorica ed applicata*, V 42 219-243. Trieste, Italy.
- Berge, Patricia, Lawrence Hutchings, Jeffrey Wagoner, and Paul Kasameyer (2001) Rock Physics Interpretation of P-wave Q and Velocity Structure, Geology, Fluids and Fractures at the Southeast Portion of The Geysers Geothermal Reservoir. *Geothermal Res. Council, Transactions*, 14, 2001 Annual Meeting, San Diego, CA.
- Kasameyer, Paul, Albert Smith, and Lawrence Hutchings (1999) Microseismicity Survey of the El Hoyo-Monte Galan Geothermal Region in Nicaragua, Regional Geothermal Conference, Nicaragua.
- Hutchings, Lawrence (project design and manager), Cynthia Hayek, Jennifer Hollfelder, Steven Jarpe, Elizabeth Foote, and Christie Turpin (1998) "Whole Lot of Shaking" Education curriculum and software for high school science students.
- Mualchin, Lalliana, Pat Hipley, Lawrence Hutchings, Jennifer Hollfelder, Steve Jarpe, and Kazuo Seo (1998) Wave Propagation along the San Francisco, California Bay Bridge. proceedings, Second International Symposium on the Effects of Surface Geology on Seismic Motion, Yokohama, Japan, December 1-3, pp 22-31.
- Hutchings, L., F.T. Wu, R.-J. Rau, S. Jarpe, P. Kasameyer, W. Foxall (1997) Strong Ground Motion Synthesis along the Sanyi-Tungshih-Puli Seismic Zone using Empirical Green's Functions. proceedings, 1997 Central Weather Bureau 100th Anniversary International Conference on Weather Analysis and Forecasting, Taipei, Taiwan, pp 22-33, March 3-5, 1997.
- Hutchings, L. and S. Jarpe (1996) Ground Motion Variability at the Highways 14 and I-5 Interchange in the Northern San Fernando Valley. *Bul Seis Soc Am* 86, no. 1B, pp S289-S299. UCRL-ID-121760.
- Foxall, B., L.J. Hutchings and P.W. Kasameyer (1996) Prediction of Strong Ground Motion based upon Physical Constraints on Fault Rupture Scenarios for Ground Motion Prediction. Lawrence Livermore

- National Laboratory, UCRL-JC-11637, accepted *Bul Seis Soc Am*.
- Hutchings, L.J., S.P Jarpe, P.W. Kasameyer and W. Foxall (1996) Synthetic Strong Ground Motions for Engineering Design Utilizing Empirical Green's Functions. proceedings Fourth Caltrans Seismic Research Workshop, pp. 24; Eleventh World Conference of Earthquake Engineering, Acapulco, June 23-28, 1996 (CDROM Elsevier); LLNL, UCRL-JC-123762.
- McCallen, D.B. and L.J. Hutchings (1996) Ground motion estimation and nonlinear seismic analysis. LLNL, UCRL-JC-121667. proceedings: 12th Conference on Analysis and Computation of the American Society of Civil Engineers, Chicago, Illinois, 1996.
- Hutchings, L., P. Kasameyer, P. Goldstein, and S. Jarpe (1994) Modeling the NPE with Finite Sources and Empirical Green's Functions. Proceedings of the Non-Proliferation Experimental Results and Implications for Test Ban Treaties, M. D. Denny, editor, L.L.N.L., Livermore, CA, Conf-9404100.
- Hutchings, L. (1994) Kinematic Earthquake Models and Synthesized Ground Motion using Empirical Green's Functions. *Bul Seis Soc Am* 84, 1028-1050.
- Zucca, John J., Larry Hutchings, Brian Bonner, Paul Kasameyer, Ernest L. Majer, John Peterson, Art Romero, Ann Kirkpatrick (1994) Microearthquake Monitoring and Seismic Imaging at The Geysers Geothermal Program Review Proceedings, San Francisco, CA. UCRGJC-117285
- Zucca, J.J., L.J. Hutchings, and P.W. Kasameyer (1994) Seismic Velocity and Attenuation Structure of the Geysers Geothermal Field, California. *Geothermics* 23, 111-126.
- Heuze, F. E., T. S. Ueng, L. J. Hutchings, S. P. Jarpe, and P. W. Kasameyer (1994) A coupled seismic-geotechnical approach to site-specific strong motion Soil Dynamics and Earthquake Engineering. 16 (4): 259-272 JUN 1997.
- Hutchings, L. (1991) "Prediction" of Strong Ground Motion for the 1989 Loma Prieta Earthquake using Empirical Green's Functions, *Bul Seis Soc Am* 81, 1813-1837.
- Hutchings, L. and Wu, F. (1990) Empirical Green's Functions from Small Earthquakes: A Waveform study of Locally Recorded Aftershocks of the 1971 San Fernando Earthquake. *J Geophys Res*, 95, 1187-1214.
- Jarpe, S.P., L.J. Hutchings, T.F. Hauk, and A.F. Shakel (1989) Selected Strong- and Weak-Motion Data from the Loma Prieta Earthquake Sequence. *Seis Res Letters*, 60, 167-176.
- Hutchings, L., Turcotte, T., McBride, J., and Ochoa, H. (1981) Microseismicity along and near the Dolores Shear Zone in Antioquia, Colombia. *Revista CIAF*, Vol 6 , No. 1-3, pp 243-256.

#### REPORTS:

- Hutchings, Lawrence, Katie Boyle, Brian Bonner, Paul Kasameyer, Nathaniel Lindsey, Laura Bendernagel (2010) Structure of the Salton Sea Geothermal Field from Interpretations of Passive Microearthquake Recordings. Final Report: PIER Project, California Energy Commission, Contract no. B/A IT.3360-001-0381. Lawrence Berkeley National Laboratory, in review.
- Godoladze, Tea, Dina Hunt, Fuad Aliyev, Avetis Arakelyan, Dogan Kalafat, Zurab Javakhishvi, Behruz Panahi, Valery Arzumanyan, Ryan Cary and Lawrence Hutchings (2006) Data Achieved for Events in the Caucasus for the CauSIN Collaboration Project. UCRL-JC-123760.
- Hutchings, Lawrence, Bill Foxall, Paul Kasameyer, Shawn Larsen, Cindy Hayek, Christy Tyler-Turpin, Jennifer Aquilino, and Laura Long (2005) Deep Borehole Instrumentation along San Francisco Bay Bridges: 1996 – 2003 and Strong Ground Motion Synthesis along the San Francisco/Oakland Bay Bridge. Final Report July 15, 2005. Also, annual progress reports. Caltrans contract no. 59A0238. UCRL-TR-2117303
- Hutchings, Lawrence and Laura Furrey (2002) Analysis of Site Response at U1A Hole at the Nevada Test site from Weak Motion Recordings. UCRL-ID 148493.
- Hutchings, L. (2001). Program NetMoment; a Simultaneous Calculation of Moment, Source Corner Frequency, and Site Specific  $t^*$  from Network Recordings. Lawrence Livermore National Laboratory, December 12, 2001, UCRL-ID 135693.
- Hutchings, Lawrence, Patricia Berge, Jeffrey Wagoner, Paul Kasameyer, Jennifer Swenson, and Megan

- Flanagan (2001) Association Among Source Parameters of Small Earthquakes, Q and Velocity Structure, Geology, and Production and Injection at The Geysers Geothermal Reservoir. pp 112.
- Hutchings, Lawrence, Paul Kasameyer, William Foxall, and Shawn Larsen (2000) "Synthetic Strong Ground Motion at the Oakland/San Francisco Bay Bridges from a M=7.25 Earthquake on the Hayward Fault", Lawrence Livermore National Laboratory, UCRL-ID-183645, pp 97.
- Hutchings, Lawrence, Steven Jarpe, Paul Kasameyer (1998) Validation of a Ground Motion Synthesis and Prediction Methodology for the 1988, M=6.0, Saguenay Earthquake. Lawrence Livermore National Laboratory, UCRL-JC-129395, pp. 36.
- Hutchings, Lawrence, Eleni Ioannidou, Steven Jarpe, and Giorgis N. Stavrakakis (1997) Strong Ground Motion synthesis for a M=7.2 Earthquake in the Gulf of Corinth, Greece using Empirical Green's Functions. Lawrence Livermore National Laboratory. UCRL-JC-129394, pp 14.
- Hutchings, L., P. Kasameyer, W. Foxall; LLNL T. V. McEvilly, R. A. Uhrhammer, R. Clymer; BSL P. Hipley, J. Bowman, M. Palmer; Caltrans S. Jarpe; ICS, UCSB W. Bakun; USGS (1997) Deep Bore Hole Instrumentation Along San Francisco Bay Bridges.  
[http://seismo.berkeley.edu/annual\\_report/ar97\\_98/node16.html](http://seismo.berkeley.edu/annual_report/ar97_98/node16.html).
- Hutchings, Lawrence, Paul Kasameyer, Steve Jarpe, and William Foxall (1997) Independent Seismic Evaluation of the 24-580-980 South Connector Ramps. Lawrence Livermore National Laboratory UCRL-CR-12320, Vol. 1, pp 37.
- Hutchings, L.J., S.P Jarpe, and P.W. Kasameyer (1996) Synthetic Strong Ground Motion at the Dumbarton Bridge from Design Earthquakes on the San Andreas, Hayward and Calaveras Faults. Lawrence Livermore National Laboratory, UCRL-ID-1232002.
- Hutchings, L. (1994) Location Capability of a Sparse Regional Network (RSTN) using a Multi-phase Earthquake Location Algorithm (REGLOC). Lawrence Livermore National Laboratory, UCRL-116110. Livermore, CA, pp 77.
- Zucca, John J., Larry Hutchings, Brian Bonner, Paul Kasameyer, Ernest L. Majer, John Peterson, Art Romero, and Ann Kirkpatrick (1994) Microearthquake Monitoring and laboratory tests at The Geysers. UCRGJC-117285, Lawrence Livermore National Laboratory.
- Hutchings, L. (1992) Modeling Earthquake Ground Motion with an Earthquake Simulation Program (EMPSYN) that Utilizes Empirical Green's Functions. Lawrence Livermore National Laboratory, UCRL-ID-105890, pp. 119.

**CONFERENCE PRESENTATION ABSTRACTS:** more than one hundred, provided on request.